THE BRAZILIAN TAX COLLECTION AND THE RATCHET EFFECT

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THE BRAZILIAN TAX COLLECTION AND THE RATCHET EFFECT

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SUMMARY

This thesis analyses the ratchet effect in the context of the performance scheme implemented by Brazilian tax collection in 1988 to reward tax officials for their effort in collecting taxes and uncovering tax violations, using panel data for 110 tax agencies from August 1989 to April 1993 and employing the GMM-system estimator. The estimates suggest the presence of ratchet effect, i.e., the more the tax officials do today, the more the tax officials are asked to do in the future. This result endangers the credibility of the Brazilian tax authority's incentive program as an incentive system.

CHAPTER 1 - INTRODUCTION

In hierarchical environments agents interact with each other time after time. All agents (subordinates) contracted with the same principal (superior) operate under formally identical contract provisions. In these contracts agents frequently have more information about their productivities (or the productivity of their division) than their principals yielding moral hazard problems. In these situations, the principal often relies on observations of performance to judge the productivity of the agents and to forecast future performance. After the principal learns the agents' productivity levels, he is motivated to treat agents differently, using, for example, the information learned to assign more difficult tasks to higher-ability agents.

The superior chooses an incentive scheme, which specifies a reward to agents. Weitzman (1980) establishes two basic incentive problems associated with a standard reward system: static and dynamic. The subordinate reacts to this incentive scheme by choosing the level of effort. In a static problem we have the dilemma where the worker or the manager will try to convince his superiors misrepresenting in hopes of influencing the plan while it is being formulated. The dynamic incentive problem arises when planners use current performance as a criterion to determine future targets. The regulator observes the productivity in the first period then rewards the individuals and updates their belief about the worker's efficiency. In the next period the superior chooses the optimal target given his posterior belief, and subsequently the agents chooses their effort and are rewarded. This behavior reduces the subordinates' incentive to produce efficiently today in order to manipulate the regulator's belief. This phenomenon has been called the "ratchet effect[1]" (see Weitzman, 1976). The ratchet effect occurs when the agent underperforms, that is, the agent will reduce his productivity in early periods to avoid being held to a higher standard in the future. This is a type of negative implicit incentive problem that, in general, occurs in long-term employment relationships.

The main objective of this study is to analyze the ratchet effect in the context of the performance scheme implemented by Brazilian tax collection in 1988 called "*Retribuição Adicional Variável*" (RAV) to reward tax officials for their efforts in collecting taxes and uncovering tax violations. The program created a bonus fund called "Fundo Especial de Desenvolvimento e Aperfeiçoamento das Atividades de Fiscalização (FUNDAF) for distribution among tax officials, that has amounted to about 68% of total fines collected[2]. This bonus is composed by an individual reward and a group reward. Both types of reward increase with the total of fines collected, subsequently both have incentives to increase their productivity. Groups' rewards are paid with 30% of available monthly revenues, while individual rewards are paid with remaining 70%. The group reward is calculated according to the efficiency of the agency relative to other agencies in the country. All members are equally compensated within a given tax agency. The individual reward compensates the official for his/her individual effort and is based on individual monthly evaluation of performance executed by supervisors of tax agencies.

The managers of tax agencies were induced to allocate resources efficiently within the tax agencies. Every month, the agencies' goals were adjusted in agreement with the past performance and, therefore, the future goals were determined. The 110

[1] The term "ratchet effect" was first introduced by Berliner (1952) in his study of the Soviet history to refer the situation when managers on a performance related contract were given higher targets if they had significantly outperformed the target in the previous period. Weitzman (1980) further introduced this concept in the principal-agent framework.
[2] See Kahn, Silva & Ziliak (2001) for more details.

tax agencies were ranked according to their performance each month. This tendency has sometimes been called the ratchet effect, because current performance establishes the point of departure for next period's target. In such situations, the agents face a dynamic tradeoff between present rewards for better current performance and future losses from the assignment of higher targets.

The investigations presented in this research indicate that the bonus program is sensitive to a tax agency past economic performance suggesting there be a ratchet effect. In addition, the Labour productivity variables – TTN and AFTN – used in this research are important components to determine the tax agency's performance.

The composition of this thesis is structured in the following manner. Chapter 2 outlines a discussion of previous relevant theories and literature on ratchet effect. Chapter 3 presents the dataset and the General Method of Moments (GMM) estimation method of our dynamic panel data model. Chapter 4 discusses the results obtained on a panel data set relative to the performance scheme implemented by Brazilian tax collection in 110 tax agencies over the period from August 1989 to April 1993 using GMM system estimator. Finally, as a conclusion, the analysis result for the main subject is summarized.

CHAPTER 2 - REVIEW OF LITERATURE

2.1. Ratchet Effect

Ratcheting is the phenomenon whereby better performance today by the agents causes the principal to upgrade her expectations concerning the agent's ability and consequently to provide lower remuneration for a given level of performance tomorrow, thereby discouraging better performance today.

The ratchet effect has been carefully studied by several authors. Freixas, Guesnerie and Tirole (1985) analyzed the ratchet effect in the context of a game and showed that the ratchet effect exists, in the sense that the planner may select a scheme which is suboptimal from a static viewpoint in order to stimulate revelation. Laffont and Tirole (1988) formalize and confirm the general intuition about the ratchet effect. They found that the ratchet effect for any first-period incentive scheme, there exist no separating equilibrium and when uncertainty about the agent's ability is small, the optimal scheme must involve a large amount of pooling. Kanemoto and MacLeod (1992) showed that competition for older workers can moderate the ratchet effect. They conclude that the existence of a market for older workers ensures that the default payoffs of the worker depend on the worker's ability, and the firm cannot use any information gained by observing first-period performance to adjust second-period piece rates.

Meyer (1995) demonstrates that dynamic incentive such as the ratchet effect is important. Meyer & Vickers (1997) investigate how comparative performance information influences the ratchet effect. They showed that, under certain circumstances, comparative performance information reduces the ratchet effect, and through this direction improves welfare. Indjejikian & Nanda (1999) described how the ratchet effect affects dynamic principal-agent relationships. They compared a consolidated structure with a specialized one and showed that the presence of ratchet effect tends to favor a consolidated structure. Consolidated structures can be created by assigning multiple responsibilities to a single employee and this way is able to avoid agency conflicts.

Dillen and Lundholm (1996) relate the ratchet effect to a contribution mechanism for a public good. Contrasting many public goods that are financed through long term contribution schemes (e.g. tax-systems), there are situations in which no such a commitment is made and contribution is set again by the central planner (tax authority) in each period. Hence, it might be that the observed (past) performance acts as a target in fixing the point of departure for next period's contribution level. This resembles a sort of ratchet effect, where future outcome is determined by the current contribution level. Chaudhuri (1998) investigated the ratchet effect in a dynamic principal-agent where the principal does not have complete information. The principal uses any information revealed by the agent's actions to extract the latter's information rent in future periods – the "ratchet principle". Chaudhuri (1998) actually find little evidence of ratcheting.

Vuslat Us (2003) investigates the persistence of currency substitution in Turkey through inclusion of a ratchet variable – the past peak value of the currency substitution – in two sub periods: 1990-93 and 1995-99. Results using an autoregressive distributed lag (ARDL) approach show that the inclusion of the ratchet variable into the model produces insignificants coefficients in the first period, but significant coefficients in the second. The ratchet effect is not evident in the overall economy. The conclusion about currency substitution not being subject to a ratchet effect should not be misleading.

Ventura, González and Cárcaba (2004) presented an empirical study to examine the evolution of productivity in the Spanish health system during the period of program-contracts applying the non-parametric Data Envelopment Analysis (DEA). The result of the empirical analysis shows that the program-contract has been subject to a ratchet effect, i.e., the more the hospital does today, the more the hospital is asked to do in future.

CHAPTER 3 - EMPIRICAL RESULTS

3.1. Data Description

This section will provide detailed information about the data set and the next section will present the empirical model and the results of the empirical analysis of this research. The data set is an unbalanced panel consisting of monthly observations from August 1989 to April 1993. The dataset includes 110 tax agencies - one central agency, ten supervisory regional agencies and 99 local agencies. See table 1 below for a list of local agencies included in this study.

Table 1: Regions and Agencies included in our sample

Groups	Agencies
North	Boa Vista, Belém, Macapá, Manaus, Monte Dourado, Porto Belém, Porto Manaus, Porto Velho, Rio Branco, Santarém
Northeast	ALF/Fortaleza, Aracaju, Araçatuba, Caruaru, Feira de Santana, Fortaleza, Ilhéus, João Pessoa, Juazeiro, Maceió, Natal, Porto Recife, Porto Salvador, Recife, Salvador, São Luiz, Teresina, Vitoria da Conquista
South	Cascavel, Caxias do Sul, Curitiba, Florianópolis, Foz do Iguaçu, Salgado Filho Airport, Imperatriz, IRF/Chuí, IRF/Porto Alegre, Joaçaba, Joinville, Londrina, Maringá, Novo Hamburgo, Santana do Livramento, Paranaguá, Passo Fundo, Pelotas, Ponta Grossa, Porto Alegre, Rio Grande, Santa Maria, Santo Ângelo, São Sebastião, Uruguaiana
Southeast	Angra dos Reis, Rio de Janeiro Airport, Bauru, Belo Horizonte, Campinas, Campos, Contagem, Curvelo, Divinópolis, Governador Valadares, Guarulhos, Guarulhos Airport, Juiz de Fora, Limeira, Monte Claros, Niterói, Nova Iguaçu, Osasco, Porto Rio de Janeiro, Presidente Prudente, Tancredo Neves Airport, Rio de Janeiro, Rio Preto, Santo André, Santos, São Jose do Rio Preto, São Paulo, Sorocaba, Taubaté, Viracopos Airport, Uberaba, Uberlândia, Varginha, Vitória, Volta Redonda
Midwest	Brasília Airport, Brasília, Campo Grande, Corumbá, Cuiabá, Goiânia, Itajaí, Mundo Novo, Ponta Porã, Remessas Internacionais

The data used in our empirical test comes from two sources. Information about performance, ranking, AFTN, TTN and fines collected are from the Brazilian tax collection authority (Departamento Secretaria da Receita Federal – Coordenação de Fiscalização). Information about the Gross Domestic Product (GDP) and energy come from IPEA, a Brazilian government research institute. GDP and fines collected were seasonally adjusted using Consumer Price Index (IPC) into 2000 prices, and then converted to 2000 dollars using the relevant exchange rate, provided by The Brazilian Central Bank.

The bonus or reward (RAV) paid to tax officials increase with the amount of fines collected. The bonus can be denoted by target plus either loss or overdue fines collected. Therefore, *Performance*, that represents the dependent variable, can be measured as the ratio of either loss or overdue fines collected per deserved resources. *Ranking* is the way to measure the relative performance in reaching pre-established goal. Ranking is a *proxy* of three performances (number of inspections or examinations undertaken, collection of overdue taxes and fines and the total amount of taxes collected). To quantify the size of agency the number of tax officials was used. There are two types of tax officials in the Secetaria da Receita Federal: auditors (AFTNs) and administrative bureaucrats (TTNs). Auditors are highly skilled; their duties include examinations of tax returns, collection of overdue taxes and fines, and supervision of tax agencies. Administrative bureaucrats usually play a more passive role in the collection procedure. The Labour productivity can as well be tested using the number of auditors (AFTN) and administrative bureaucrats (TTNs). I also constructed quarterly dummies for the period from August 1989 to April 1993, because the targets based on fines collected were adjusted on basis of the average of the last three months.

Table 2: Descriptive statistics

	Obs.	Mean	Std. Dev.	Min	Max
Performance	4159	119.27	22.25	-106.83	355.48
TTN	4581	49.77	60.43	1	570
AFTN	4581	53.08	85.86	1	618
Ranking	4671	53.71	30.6	1	110
Fines	3201	456093.6	1054789	0	1.11e+07
GDP	4725	28730.65	47337.08	48.95	349735.3
North	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	453	115.95	22.32	4.99	195.9
TTN	473	27.37	17.62	1	86
AFTN	473	22.61	23.55	1	86
Ranking	480	55.02	31.70	1	110
Fines	306	96917.07	118039.7	314.04	655284.4
GDP	495	2939.47	4083.55	48.95	23663.51
Northeast	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	713	117.89	22.38	48.32	189.02
TTN	736	40.24	22.29	7	114
AFTN	736	35.62	32.76	5	156
Ranking	788	71.08	26.77	4	109
Fines	510	157522.9	182961.5	5721.58	1119249
GDP	810	5783.40	7213.92	186.43	43468.21
South	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	924	124.72	21.29	32.91	210.25
TTN	956	40.5	24.77	12	147
AFTN	956	33.95	24.63	9	125
Ranking	958	46.01	27.16	1	105
Fines	718	246226.8	391719.5	8993.09	2538288
GDP	1080	18099.35	16803.02	2090.07	89679.86
Southeast	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	1635	116.2	21.9	-106.83	355.48
TTN	1771	57.74	62.61	3	418
AFTN	1771	76.74	112.94	5	618
Ranking	1787	50.77	31.95	1	109
Fines	1199	737496.7	1563102	0	1.11e+07
GDP	1935	56149.95	62833.95	847.7	349735.3
Midwest	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Performance	334	122	22.48	57.14	191.31
TTN	387	92.96	138.23	1	570
AFTN	387	77.69	136.25	1	600
Ranking	394	44.63	25.21	1	108
Fines	264	242351.7	539744.5	0	5490269
GDP	405	3494.5	3284.93	419.48	19377.73

The tax agencies were classified into regions based on their geographical localization: North, Northeast, South, Southeast and Midwest. Table 2 presents key descriptive statistics of the data. The mean Performance is 115.95, with the maximum of 355.48 and minimum of -106.83 in Southeast. South presented the highest average performance. The average Ranking is 53.71. Midwest and South exhibited the lowest average ranking while Northeast and North featured the highest average. Moreover, there is considerable difference between the average GDP of the richest region and those of the poorest. North and Northeast were the lowest fines collected and South and Southeast presented the highest GDP. This phenomenon is strongly related with the economic capacity for each region. Fines collected in North is only 21 *per cent* of the national average, while in Southeast it is 162 *per cent*, more than twice as great. There is a large variance in number of AFTN's within Midwest and Southeast, which can be explained by reallocation of the staffs to increase the amount of taxes collected.

Table 3: Correlation Matrix (2782 observations)

	Performance	Ranking	TTN	AFTN	Fines	Energy	GDP	North	Northeast	South	Southeast	Midwest
Performance	1.0000											
Ranking	-0.1592	1.0000										
TTN	-0.0911	-0.0984	1.0000									
AFTN	-0.0890	-0.1292	0.8973	1.0000								
Fines	-0.0108	-0.2049	0.6376	0.7053	1.0000							
Energy	-0.0823	-0.2355	0.0924	0.2483	0.2251	1.0000						
GDP	-0.1251	-0.1568	0.1081	0.1618	0.1187	0.6486	1.0000					
North	-0.0374	0.0523	-0.1573	-0.1261	-0.0976	-0.2457	-0.1846	1.0000				
Northeast	-0.0336	0.2773	-0.0686	-0.0768	-0.0905	-0.3223	-0.2201	-0.1608	1.0000			
South	0.1596	-0.0923	-0.0387	-0.0961	-0.0852	-0.3598	-0.1244	-0.1949	-0.2623	1.0000		
Southeast	-0.1196	-0.1212	0.1716	0.2551	0.2190	0.8462	0.4868	-0.2771	-0.3728	-0.4518	1.0000	
Midwest	0.0526	-0.0854	0.0276	-0.0548	-0.0206	-0.2170	-0.1565	-0.1040	-0.1400	-0.1697	-0.2412	1.0000

Table 3 provides us with information about correlation coefficients. The first column is particularly important because it informs us about the correlation coefficient between the dependent variable and each of the explanatory variables. These correlation coefficients permit us to see whether our regression results may suffer from multicolinearity problems and also give us some clues about the expected signs of our regression coefficient estimates. The Performance is not highly correlated with any of the independent variables. The highest correlation coefficient in the first column is -0.1596 (South). The high correlation in the second column, 0.2773 (Northeast) inform us that the tax agency grouping Northeast has the worse ranking. It is worth mentioning that the correlation coefficient between Tax and AFTN (0.7053) and Tax and TTN (0.6376) are very high. It is not surprising because fines collected should be an increasing function of TTN and AFTN. Southeast has a positive and high correlation with energy and GDP which tell us that southeast is a rich economic area.

3.2. Empirical procedure

This paper will test the existence of a ratchet effect in the bonus program to compensate tax officials for their efforts in collecting taxes created by Brazilian government, using monthly data from 110 tax agencies in the country – one central agency, ten supervisory regional agencies and 99 local agencies – from August 1989 to April 1993.

Some of the advantages of using the panel data approach are: availability of a large number of data points help in reducing problem of limited degrees of freedom and enhance the efficiency of the estimators; problem of multicolinearity is less likely since explanatory variables vary in two dimensions; problem of omitted variables can be reduced by explicitly modeling unobserved variables as a unit-specific effect or time-specific effect or both.

The ratchet effect means that the better the execution in one period, the larger the increase in the targets for the next period. The Performance level provides a reasonable target variable for the empirical model. An increment in the Performance level can be reached by increasing the amount of fine collected, the relative efficiency in realization pre-established goal - ranking[3] - and by decreasing the average number of auditors and high-level supervisors assigned (AFTNs) and administrative bureaucrats (TTNs). It is reasonable to assume that the monthly variation in the target will depend on the last period's performance and last period's target.

The variation in the performance scheme targets may depend on the tax agency's efficiency. A very inefficient tax agency could increase the amount of fine collected (and thus the target) more than a very efficient tax agency, without an additional increase in input endowment. Thus, raise the ranking should be inversely correlated with variations in targets. A small number of AFTN in the tax agency would allow an augment in the efficiency, and consequently, in the Performance level. Therefore, if a small number of AFTN translates into a greater Performance level for the following month, this should also increase the formation of next period's target.

The model estimated in this study will take the form of a dynamic panel data econometric model to test the existence of a ratchet effect. The econometric specification for our empirical model is the following:

$$Performance_{i,t} = \alpha_1 Performance_{i,t-1} + \alpha_2 Fines_{i,t} + \alpha_3 TTN_{i,t} + \alpha_4 AFTN_{i,t} + \beta X_{i,t} + \delta_i + \delta_t + \varepsilon_{i,t} \quad \textbf{(1)}$$

where $X_{i,t}$ can be a vector of explanatory variables some of which are predetermined or endogenous defined in the previous section. The vector X can include current and lagged dependent variables. The subscript i and t denote tax agency and time period, respectively; δ_i is a tax agency fixed effect, δ_t is a time effect, and $\varepsilon_{i,t}$ is the error term.

[3] Ranking is a *Proxy* of three performances (number of inspections or examinations undertaken, collection of overdue taxes and fines e the total amount of taxes collected) utilized to define the tax agencies' target.

There are several estimation problems that may occur in estimating these empirical models. In such a formulation least-squares estimates are biased both in the case that unobservable tax agency-specific effects (δ_i) are statistically significant, and in the case that regressors and these effects are correlated. Further, there exists a significant relationship between Performance level in t and $t-1$; for this reason; we include the lagged dependent variable $(Performance_{i,t-1})$ in our empirical model. In such a framework, OLS results in inconsistent estimates since $Performance_{i,t-1}$ and δ_i are necessarily correlated, even if the idiosyncratic component of the error term is serially uncorrelated[4]. The tax agency-specific effects (δ_i) can be eliminated by taking first-differences. However, OLS still does not consistently estimate the parameters of interest because $Performance_{i,t-1}$ and $\varepsilon_{i,t}$ are correlated trough the terms $Performance_{i,t-1}$ and $\varepsilon_{i,t-1}$. A different solution to first differences transformation is the within transformation; however, and even though controlling for fixed effects, the within transformation leads to consistent estimates only under the hypothesis of strictly exogenous regressors. Since the model estimated is a dynamic model, the dependent variable may be subject to measurement errors, which induce biases in the estimates.

The presence of unobserved tax agency-specific effects and the possible endogeneity of the explanatory variable can be confronted by using instruments for the potentially endogenous variables and employing Generalized Method of Moments (GMM) estimators. Arellano and Bond (1991) proposed a Generalized Method of Moment (GMM) estimator that first-differences the dynamic equation, and uses lagged variables as instruments in order to obtain efficient estimates.

[4] See Blundell and Bond (1998).

Endogenous variables in levels lagged two or more periods will be valid instruments, provided there is no autocorrelation in the time-varying component of the error terms. This is tested by examining tests for serial correlation in the first-differenced residuals, following Arellano and Bond (1991). When the model does not include an unobserved tax agency-specific effect, the model is estimated in levels, for both the regression equation and the set of instruments. This is called the GMM levels estimator. When the model includes an unobserved tax agency-specific effect (resulting from time invariant omitted factors such as symmetric measurement error), the model is estimated in both differences and levels, jointly in a system. This is called the GMM system estimator. The GMM system estimator was developed by Blundell and Bond (1998) and it presents a significant improvement over the other panel estimation methods such as the first-difference GMM estimator.

3.3. GMM Estimators

The simplest model without strictly exogenous variables is an autoregressive specification of the form

$$y_{it} = \alpha y_{i(t-1)} + \eta_i + v_{it} \qquad |\alpha| < 1 \tag{2}$$

Where y_{it} is an observation on some series for individual i in period t, $y_{i(t-1)}$ is the observation on the same series for the same individual in the previous period, η_i is an unobserved tax-agency specific time-invariant effect which allows for heterogeneity in the means of the y_{it} series across individuals, and v_{it} is a disturbance term. We assume that a random sample of N individual time series $(y_{i1}, \dots y_{iT})$ is available. T is small and N is large. The individual effects (η_i) are treated as being stochastic, which implies they are necessarily correlated with the lagged dependent variable $y_{i(t-1)}$ unless the distribution of the η_i is degenerate. The v_{it} are assumed to have finite moments and in particular $E(v_{it}) = E(v_{it}v_{is}) = 0$ for $t \neq s$. That is, we assume lack of serial correlation but not necessarily independence over time.

Dynamic panel data models estimated using the Generalized Method of Moments (GMM) have become an important tool in the empirical analysis of microeconomic panels with a large number of individual units and relatively short time series.

By Blundell and Bond (1998), the instruments used in the standard first-difference GMM estimator, that is, estimators relying on lagged levels as instruments for current differences are likely to perform poorly when the series are close to a random walk, and when the variance of the tax-agency specific effect (η_i) increases relative to the variance of the transitory shocks (v_{it}). In this case the available instruments are only weakly correlated with the endogenous variables, and the GMM estimator is likely to suffer from serious finite sample bias, as well as imprecision. Instead they suggest the system generalized method of moment estimator, that is, the estimation of a simultaneous system of two equations. In this model, the instrumental variable is not only the lagged level of the explaining variables in the first difference equations, but also the lagged differences of the explaining variables in the level equations. One set of equations are the differenced equations:

$$(y_{it} - y_{i,t-1}) = \beta(y_{i,t-1} - y_{i,t-2}) + \gamma(x_{it} - x_{i,t-1}) + (v_{it} - v_{i,t-1}) \quad \textbf{(3)}$$

Since the differenced lagged dependent variable and differenced error term are correlated OLS estimator of (3) will not produce a consistent estimate of β, even if the regressor, x_{it}, is strictly exogenous, that is, $E(x_{it}v_{is})=0$ for all s,t. Thus, valid instruments have to be found for $\Delta y_{i,t-1}=(y_{i,t-1}-y_{i,t-2})$. Assuming that the errors are independent across tax agency and serially uncorrelated - $E(v_{it}v_{is})=0$ for $s \neq t$ - and that the initial conditions satisfy $E(y_{i1}v_{it})=0$ for $t \geq 2$, then values of y_{it} lagged two periods or more are valid instruments in the first differenced growth equation, since $y_{i,t-2}$ and earlier values are generally correlated with $\Delta y_{i,t-1}$, but not with Δv_{it}.

The other set of equations in the system are the levels equation

$$y_{it} = \alpha + \beta y_{i,t-1} + \gamma x_{it} + \eta_i + v_{it} \qquad \textbf{(4)}$$

Where the x_{it} regressor satisfies $E(\Delta x_{it}\eta_i)=0$ and the initial conditions satisfy the restriction $E(\Delta y_{i2}\eta_i)=0$.

3.4. The Sargan/Hansen test of overidentifying restrictions

A fundamental assumption for the validity of GMM estimates is that the instruments are exogenous. The basic specification test for GMM estimators is the Sargan (1958)/Hansen (1982) test of overidentifying restrictions. The Sargan/Hansen test for joint validity of the instruments is standard after GMM estimation.

The consistency of the parameters obtained by means of the GMM estimator depends on the validity of the instruments. The validity of the instruments is in each case tested based on two specification tests suggested by Arellano and Bond (1991) and Arellano and Bover (1995). The first test is the Sargan test of overidentification restrictions, which test the null hypothesis of overall validity of the instruments used. Failure to reject this null hypothesis provides support to the choice of the instruments. The test for serial correlation of the error is also reported, which tests the null hypothesis that the differenced error term is first and second order serial correlated.

Failure to reject the null hypothesis of no second-order serial correlation implies that the original error term is serially uncorrelated and the moment conditions are correctly specified.

The Arellano-Bond test for autocorrelation is actually valid for any GMM regression on panel data, including OLS and 2SLS, as long as none of the regressors is “post-determined”, depending on future disturbances. A fixed effect or Within Groups regression can violate this assumption if *T* is small.

Since the moment conditions used by the first-differenced GMM estimator are a strict subset of those used by the system GMM estimator, a Difference-Sargan test proposed by Blundell and Bond (1998) is based on difference between the two standard Sargan statistics and provides a more specific test of the additional moment conditions exploited by the system GMM estimator. The Difference-Sargan test is a test of the additional moment conditions used in the system GMM estimators relative to the corresponding first-differenced GMM estimators. The difference-Sargan test is obtained by comparing the Sargan statistics of a restricted and an unrestricted model, the restricted model also including the additional instruments and moment conditions.

CHAPTER 4 - EMPIRICAL RESULTS

This section presents the results of the regressions on performance to test the ratchet effect. The main econometric methodology is the GMM system estimator. For each regression, I test the specification of equation with the Sargan test of over identifying restrictions, and then with the Arellano-Bond test for the second order serial correlation. The test results demonstrate that all GMM system regressions satisfy the specification tests[5], which indicates that our instruments are valid and there exists no evidence of second order serial correlation in our regressions.

As a reference, I have estimated the OLS, Within Groups, 2SLS estimator for the equations in first differences, and the difference GMM estimators. One immediate problem in applying OLS to this model is that $Performance_{t-1}$ is endogenous to the fixed effects in the error term, which gives rise to dynamic panel bias. In particular, the OLS levels increase the coefficient estimate for lagged performance by attributing predictive power to it that actually belongs to the tax agency's fixed effect.

There are two ways to work around this endogeneity. One, the difference GMM, uses equation in first-differences to eliminate the tax agency-specific fixed effects. Endogenous variables in levels lagged two or more periods will be valid instruments, provided there is no autocorrelation in the time-varying component of the error terms[6]. The other, GMM system, the differenced equations –using level instruments– are combined with equations in level - using differences as instruments.

The regression estimated for the period August 1989 to April 1993 reported the following results:

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[5] In the context of GMM system estimator the residual of the regression is the original error term in differences and thus is expected to exhibit first-order but not second-order serial correlation.

[6] This is tested by examining tests for serial correlation in the first-differenced residuals, following Arellano and Bond (1991).

Table 4: Regression results: Ratchet effect

	OLS LEVELS	WITHIN GROUPS	2SLS DIFF	GMM DIF t-2	GMM DIF t-3	GMM SYS t-2	GMM SYS t-3
$Constant$	40.9672*** (3.024)	56.50*** (5.56)	-0.9118* (0.533)			87.37*** (8.11)	81.43*** (6.31)
$Performance_{t-1}$	0.6599*** (0.026)	0.5849*** (0.034)	0.416*** (0.100)	0.5528*** (0.094)	0.5543*** (0.068)	0.4171*** (0.037)	0.43*** (0.038)
$Fines_t$	1.94e-06* (1.06e-06)	3.16e-06*** (1.01e-06)	2.14e-07 (3.54e-07)	0.0000354** (0.000013)	0.0000351*** (0.000013)	0.0000395** (0.0000153)	0.0000419** (0.000015)
TTN_t	-0.026** (0.012)	-0.2727*** (0.078)	-0.014*** (0.004)	-0.3139** (0.134)	-0.4283*** (0.119)	-0.378*** (0.096)	-0.281*** (0.079)
$AFTN_t$	-0.007 (0.01)	0.089*** (0.040)	0.0068* (0.003)	2.135*** (0.583)	2.002*** (0.563)	-0.264 (0.153)	-0.277** (0.118)
$AR(1)$	-4.23		-5.32	-5.17	-5.66	-5.93	-5.84
$AR(2)$	-0.04***		-0.10***	-0.27***	-0.22***	-0.73***	-0.78***
Sargan Test				0.000	0.000	0.000	0.771
Dif-Sargan	-	-	-	-	-	0.791	0.503

Notes: Quarters dummies variables are included as instruments in GMM specifications. Standard errors reported in parentheses. AR (1) and AR (2) are tests for first-order and second order serial correlation, asymptotically N (0, 1). These test the levels residuals for OLS levels, and the first-differenced residuals in all columns. GMM results are two-step estimates with heteroskedasticity-consistent standard errors and test statistics. Sargan is a test of the overidentifying restrictions for the GMM, asymptotically χ^2. P-value is reported. This test uses the minimized value of the corresponding two-step GMM estimators. ***, ** and * indicate coefficient at the 1%, 5% and 10% level, respectively. Estimations performed using GMM-system procedure combining transformed and level instruments. Variables instrumented: Performance, Energy and GDP.

The first three columns in table 4 present the OLS estimates of the Ratchet effect in levels, the within groups and 2SLS estimator for the equations in first differences. The within groups and 2SLS estimator for the equations in first differences estimators are added here for comparison. The within groups estimates for the Ratchet effect are quite similar to the OLS results. For the lagged dependent variable the estimate is reduced to 0.58, suggesting less persistence in the performance[7]. The serial correlation tests AR (1) and AR (2) reported for OLS levels do not reject the null hypothesis of no first order serial correlation, but reject the null hypothesis of no second order serial correlation. This need

[7] As expected in the presence of tax agency-specific effects, OLS levels appears to give an upwards-biased estimate of the coefficient on the lagged dependent variable, while the within-groups estimate appears to give a downwards-biased estimate of this coefficient (see Bond 2002).

not indicate that the AR(1) model is misspecified, since the estimates of these residuals are likely to be biased (see Bond 2002). The OLS and within groups results do not control for the potential endogeneity of some of the explanatory variables. Moreover, an estimating model by OLS usually presumed that factors, such as a manager's capability within tax agencies, skill of the tax agents, types of taxpayers residing in the region, affects the performance. For example, the tax agency has good resources, such as manager's capability and the skill of the tax agent etc. that cannot be observed, that it can accomplish more performance.

Columns (4) and (5) present the two-step first-differenced GMM estimators. For the GMM estimators, the reported test statistics consider serial correlation in the first-differenced residuals, but the null hypothesis of no second-order serial correlation is rejected. The validity of the lagged levels dated t-2 and t-3 as instruments in the first-differenced equations is clearly rejected by the Sargan test of overidentifying restrictions[8]. The Sargan test confirms a misspecification problem. In other words, the chosen instrumental variables are correlated with the disturbance. This is consistent with the presence of measurement errors. The parameters may not be identified using first-differenced GMM estimators when the series are random walks, and more generally identification may be weak when the series are near unit root processes (Bond 2002)[9].

The results in the fifth and sixth columns are obtained using GMM system estimators. The results for GMM system estimator are supported by the specification test. The system GMM parameter estimates appear to be reasonable, because it has much smaller finite sample bias and much greater precision when estimating autoregressive parameters using persistent series. There is an increase in the power of the Sargan test to reject the instruments used in the first differenced equations.

[8] P-value reported.

[9] AR (1) models, including quarter dummies, are estimated to examine the rate of persistence in data. See tables A.1 and A.2 in Appendix A.

However, I find that the AFTN variable that was insignificant in column (6) becomes statistically significant in column (7).

I have implemented the full two-step GMM system estimator, using the finite-sample correction for the two-step covariance matrix proposed by Windmeijer (2000)[10]. With regard to the GMM system specification adopted the regression in columns (6) and (7) are supported by the Sargan test, thus confirms that the instruments used are valid (i.e. the instruments used are not correlated with the errors). As expected there is evidence for first-order serial correlation, while there is no evidence of second-order serial correlation.

The significance of the lagged value of performance in all the estimated models indicate that the dynamic specification used is appropriate and the estimated coefficient confirms the existence of a ratchet effect in the bonus program between August 1989 and April 1993. The coefficient of Performance is positive and statistically significant in all specification. Thus, the better performance in reach the target today by the agents, the larger the increase of the target in the following period.

The coefficients of the Labour productivity variables – TTN and AFTN – have negative signs, as expected. This was to be expected under the hypothesis that the bonus program would exert more pressure on the most inefficient tax agencies. The result is significantly different from zero for administrative bureaucrats (TTNs) and for High-level supervisors assigned (AFTNs). The variable (TTNs) is a proxy for size of the tax agency, an increase in the size of the agency would be associated with a reduction in the performance.

Fines collected appear to be significantly and positively correlated with performance, although its effect on performance is small in magnitude. This result

[10] The two-step procedure was used to obtain efficient and consistent estimates, which explores residuals from the first step to construct the consistent estimate of variance-covariance matrix.

suggests that the information about the real fines collected is used in the Brazilian tax authority's incentive program as a reference to set the targets. The signs for AFTN did not coincide in all the regressions.

Table 5: Alternative Regression results: Ratchet effect

	OLS LEVELS	WITHIN GROUPS	GMM DIF t-2	GMM DIF t-3	GMM SYS t-2	GMM SYS t-3
$Constant$	52.61*** (3.81)	61.52*** (6.16)			87.05*** (9.99)	89.73*** (5.85)
$Performance_{t-1}$	0.543*** (0.035)	0.4544*** (0.04)	0.4616*** (0.094)	0.4627*** (0.065)	0.3291*** (0.07)	0.25*** (0.038)
$Fines_t$	-7.68e-08 (8.08e-07)	1.12e-06 (9.88e-07)	0.0000369** (0.000014)	0.0000349** (0.000014)	2.95e-07 (6.19e-06)	8.03e-06 (5.39e-06)
TTN_t	0.042** (0.017)	-0.058 (0.046)	-0.3212** (0.148)	-0.4387*** (0.133)	-0.296*** (0.094)	-0.108 (0.075)
$AFTN_t$	-0.034*** (0.01)	-0.054** (0.027)	2.147*** (0.678)	2.27*** (0.698)	-0.017 (0.103)	-0.127 (0.102)
$AR(1)$	-2.70		-4.82	-5.35	-4.59	-5.09
$AR(2)$	1.35***		-0.63***	-0.52***	0.16***	-0.36***
Sargan Test			0.000	0.000	0.010	0.019
Dif-Sargan	-	-	-	-	0.352	0.616

Notes: Monthly dummies variables are included (but not reported) in all specifications. Standard errors reported in parentheses. AR (1) and AR (2) are tests for first-order and second order serial correlation, asymptotically N (0, 1). These test the levels residuals for OLS levels, and the first-differenced residuals in all columns. GMM results are two-step estimates with heteroskedasticity-consistent standard errors and test statistics. Sargan is a test of the overidentifying restrictions for the GMM, asymptotically χ^2. P-value is reported. This test uses the minimized value of the corresponding two-step GMM estimators. ***, ** and * indicate coefficient at the 1%, 5% and 10% level, respectively. Estimations performed using GMM-system procedure combining transformed and level instruments. Variables instrumented: Performance, Energy and GDP.

The results in table 5 show alternative results of the regressions on performance to test the ratchet effect including monthly time dummies as independent variables to capture time varying effects and correct for seasonality in collecting fines. The system GMM parameter estimators for fines collected and high-level supervisors assigned (AFTN) in column (5) become statistically insignificant when time dummies are included if compared to those results reported in table 4.

CONCLUSION

I have analyzed the ratchet effect in the context of the performance scheme implemented by Brazilian tax collection to reward tax officials for their efforts in collecting taxes and uncovering tax violations, using an unbalanced panel data for 110 tax agencies from August 1989 to April 1993 and employing the GMM-system estimator.

The empirical evidence and econometrics results show that the main negative aspect of The Brazilian tax authority’s incentive program is its credibility as an incentive scheme; in that bonus for individual performance were poorly managed, with nearly all staff members receiving the maximum score. Instead, the presence of ratchet effect was verified and the program had been incorporated a ratchet effect, i.e., the better the accomplishment, the larger the target in the subsequent period.

This paper is one of the first papers which try to model the complex phenomena of ratcheting in Public Sector. The main finding of this research is that the bonus program is sensitive to a tax agency past economic performance. In addition, the Labour productivity variables – TTN and AFTN – used in this research are important components to determine the tax agency’s performance. It is also a proxy for the tax agency characteristics, such as the size of the tax agency, as larger the tax agency worse is its performance.

APPENDIX A – AR(1) SPECIFICATION FOR THE SERIES

Table A.1: Alternative Estimates of the AR (1) Specification

Dependent Variable: $Performance_t$

	OLS Levels	Within Groups	2SLS DIF	GMM DIF	GMM DIF
$Performance_{t-1}$	0.537*** (0.025)	0.458*** (0.030)	-0.875*** (0.114)	0.164*** (0.039)	0.168*** (0.036)
AR(1)	-5.54		6.53	-6.49	-6.66
AR(2)	1.10		-2.39	-1.54	-1.52
Sargan				0.033	0.812
Instruments			$Performance_{t-2}$	$Performance_{t-2}$ $Performance_{t-3}$	$Performance_{t-2}$ $Performance_{t-3}$ $Performance_{t-4}$

Notes: Quarters dummies included in all models (but not reported) Quarters dummies variables are also included as instruments in GMM-diff. specifications. Standard errors reported in parentheses. AR (1) and AR (2) are tests for first-order and second order serial correlation, asymptotically N (0, 1). These test the levels residuals for OLS levels, and the first-differenced residuals in all columns. GMM results are two-step estimates. Sargan is a test of the overidentifying restrictions for the GMM, asymptotically χ^2. P-value is reported. This test uses the minimized value of the corresponding two-step GMM estimators. ***, ** and * indicate coefficient at the 1%, 5% and 10% level, respectively.

Table A.2: AR (1) Model Estimates

$Fines_t$	OLS Levels	Within Groups	GMM DIF t-3	GMM Sys t-3
$Fines_{t-1}$	0.928*** (0.026)	0.382*** (0.040)	0.218*** (0.049)	0.726*** (0.040)
AR(1)	-2.59		-2.54	-2.50
AR(2)	-1.56		-1.02	-0.71
Sargan			0.006	0.402
TTN_t	**OLS Levels**	**Within Groups**	**GMM DIF t-3**	**GMM Sys t-3**
TTN_{t-1}	0.997*** (0.001)	0.895*** (0.019)	0.608*** (0.051)	0.973*** (0.007)
AR(1)	1.79		-3.61	-3.86
AR(2)	1.26		0.83	-1.79
Sargan			0.025	0.999
$AFTN_t$	**OLS Levels**	**Within Groups**	**GMM DIF t-3**	**GMM Sys t-3**
$AFTN_{t-1}$	0.992*** (0.001)	0.931*** (0.016)	0.609*** (0.072)	0.986*** (0.002)
AR(1)	-1.61		-3.07	-3.23
AR(2)	0.55		2.25	2.27
Sargan			0.031	0.036
$Ranking_t$	**OLS Levels**	**Within Groups**	**GMM DIF t-3**	**GMM DIF**
$Ranking_{t-1}$	0.816*** (0.016)	0.596*** (0.020)	0.045 (0.045)	0.084*** (0.040)
AR(1)	-7.28		-5.63	-6.12
AR(2)	1.90		-0.88	-0.21
Sargan			0.071	0.897

Notes: Quarters dummies included in all models (but not reported) Quarters dummies variables are also included as instruments in GMM-diff. specifications. Standard errors reported in parentheses. AR (1) and AR (2) are tests for first-order and second order serial correlation, asymptotically N (0, 1). These test the levels residuals for OLS levels, and the first-differenced residuals in all columns. GMM results are two-step estimates. Sargan is a test of the overidentifying restrictions for the GMM, asymptotically χ^2. P-value is reported. This test uses the minimized value of the corresponding two-step GMM estimators. ***, ** and * indicate coefficient at the 1%, 5% and 10% level, respectively.

Table A.2 reports simple AR (1) for the four series, Fines, TTN, AFTN and Ranking. All four series are found to be highly persistent, with OLS level estimates near an exact unit root. For TTN and AFTN series, system GMM estimators recommend an autoregressive coefficient around 0.98.

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